NOAA FISHERIES

Northwest Fisheries Science Center

# Effects of vessels on southern resident killer whale behavior

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Northwest Fisheries Science Center

West Coast Marine Mammal Program Review

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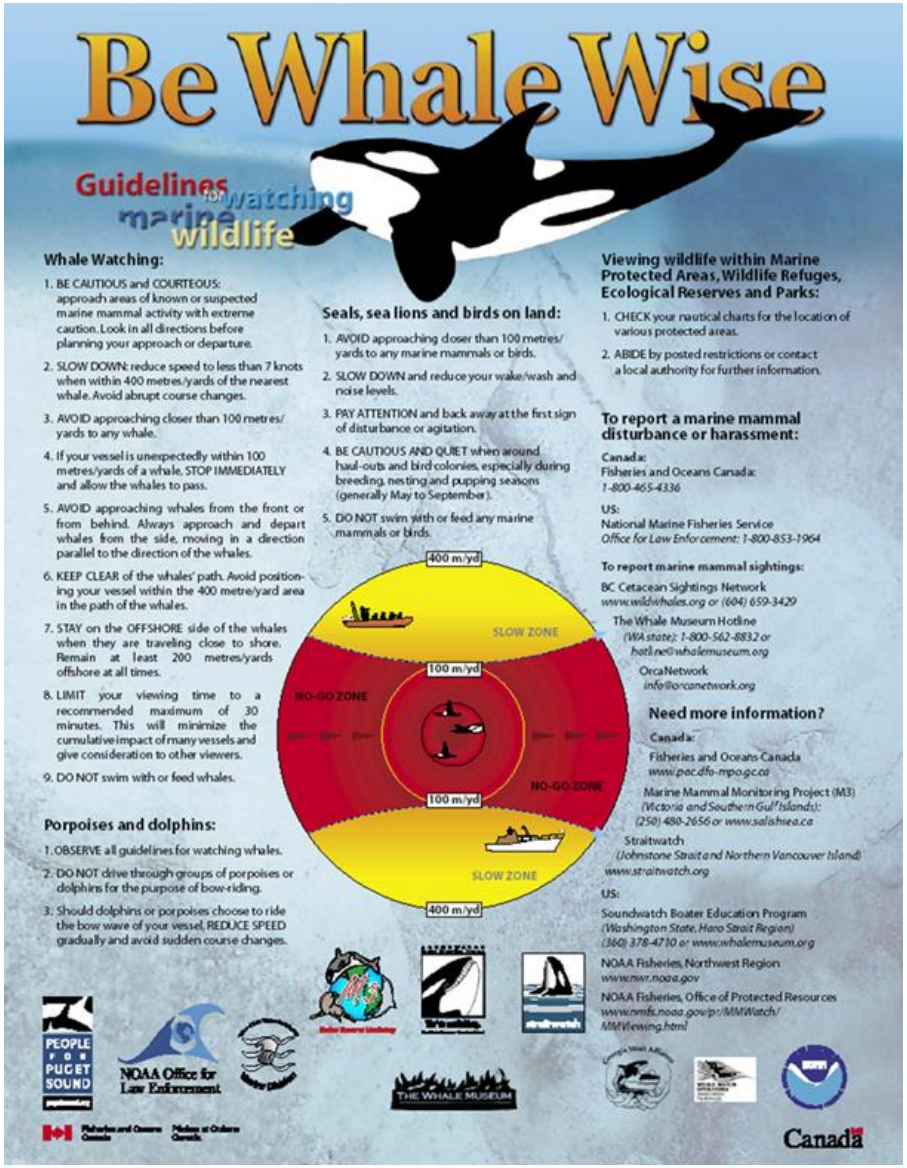
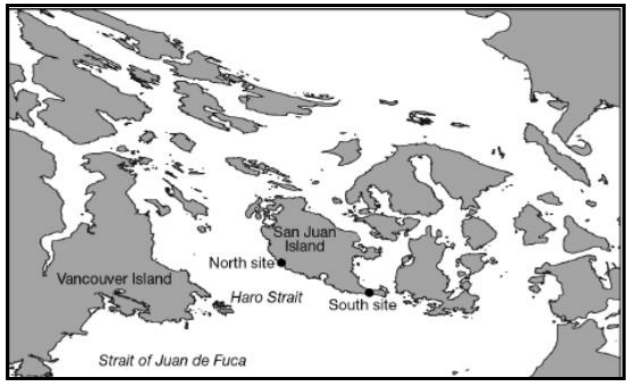
# Vessel Presence


Studies that addressed management needs relevant to proposed vessel regulations

# Voluntary Guidelines



# Land-Based Theodolite SRKW Behavioral Study
# David Bain (2003-2005)



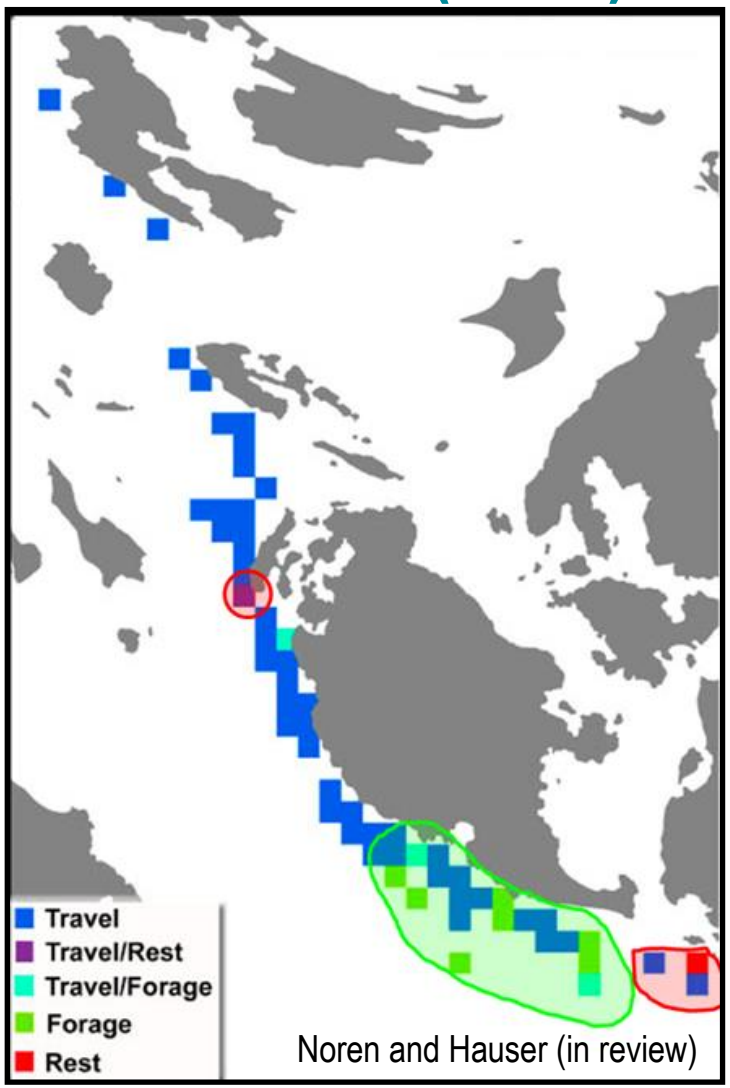

- Scan sample (Lusseau *et al.* 2009)
  - ↓ Foraging and ↑ travel when boats are within 100 m and from 100 - 400 m of whales
- Focal follow (Williams *et al.* 2009)
  - Changes in respiration rate, swim speed, path directedness, and occurrence of surface active behaviors (SABs) when boats are within 0 to ≥400 m
  - ↑ Performance of SABs in response to close approaches by vessels and ↑ vessel presence

# Boat-Based Focal Follow SRKW Behavioral Study
# Dawn Noren (2004-2006)



- Spatial and temporal relationships between close approaches by vessels and surface active behaviors (SABs, Noren *et al.* 2009)
  - SAB bouts ↑ when vessel distance to whale ↓
    - Significantly higher proportion of SAB bouts occur when vessels are within 0 to 150 m of whales
  - SAB bouts ↑ near the time of the closest approach by a vessel

# Boat-Based Scan Sample SRKW Behavioral Study
## Dawn Noren (2006)

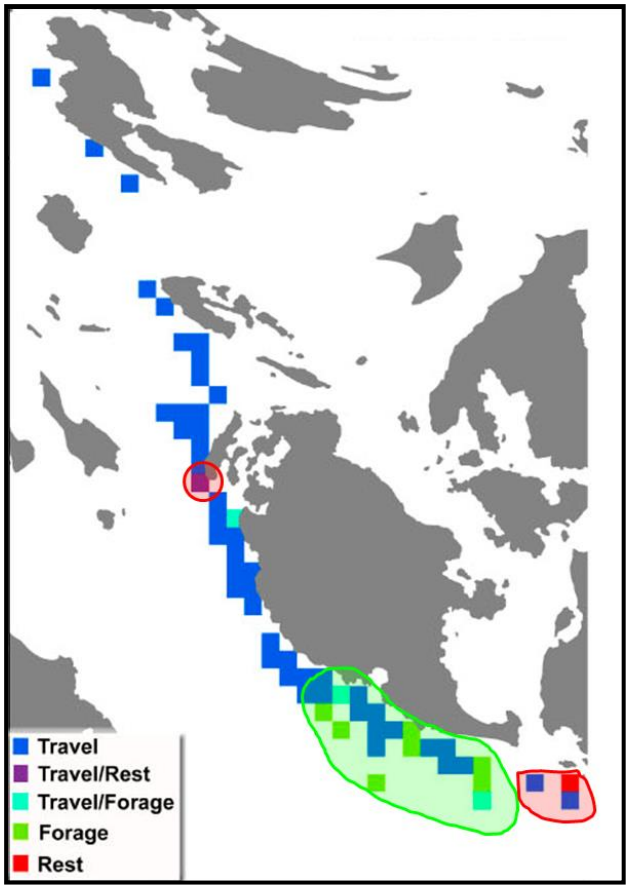




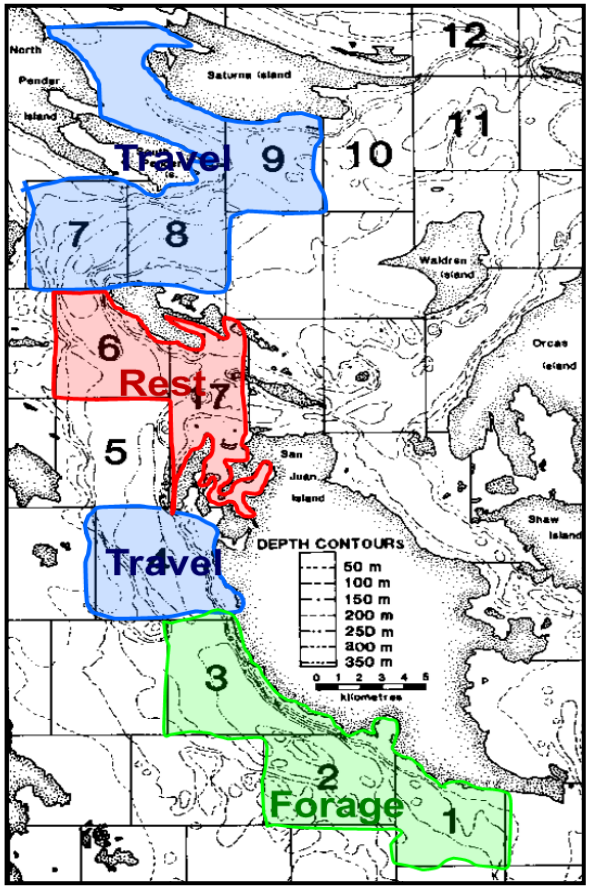

- Some SRKW activity states predominantly occur in distinct locations
  - Rest – 2 locations
  - Forage – Primarily southwest of San Juan Island

# Persistent Activity State Hot Spots

2006 (Noren and Hauser in review)




1976-83 (Heimlich-Boran 1988)



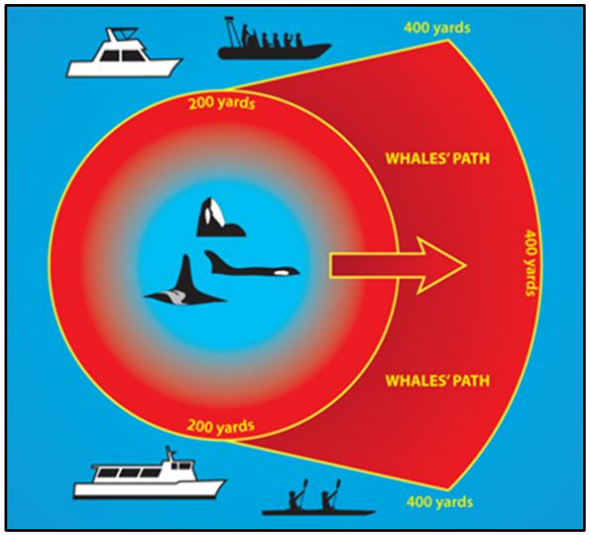

Forage: Southwest of San Juan Island

Rest: Northwest of San Juan Island

# Research Efforts Resulted in Management Actions

- Common results across studies
  - Various SRKW behavioral changes occur when vessels are within close proximity (0 m to ≥ 400 m)

- Vessel Regulations (2011)



# Vessel Presence and Noise


Bioenergetic model to assess the biological significance of responses to vessels

(Noren, Holt, and others)

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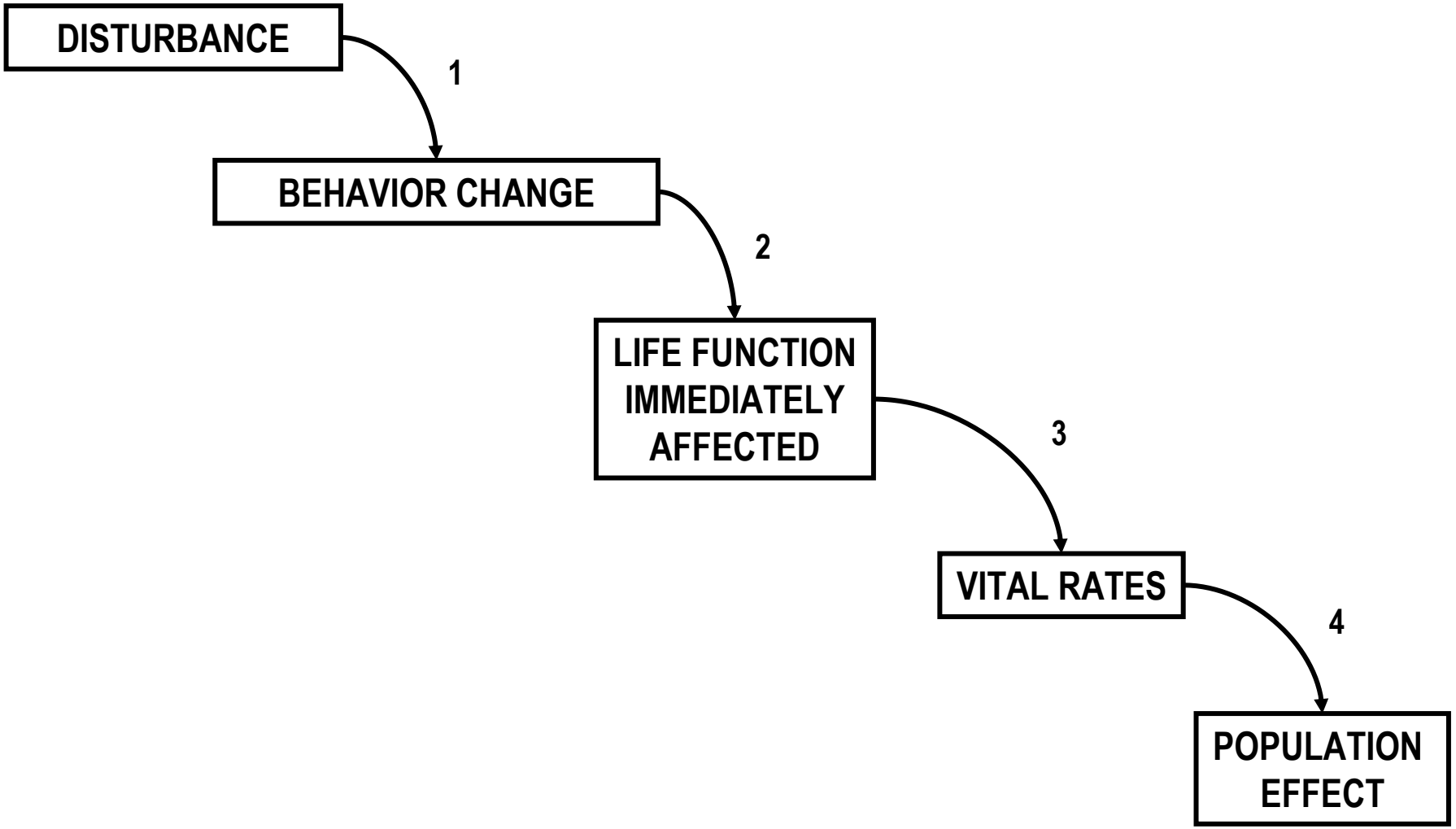
# Population Consequences of Disturbance



# Population Consequences of Disturbance

**DISTURBANCE**
**Vessels**
**(Presence & Noise)**

1

**BEHAVIOR CHANGE**
↑ Surface active behaviors
Changes in swim speed
Switching from forage to travel (↑ swim speed)
Vocal modifications

2

**LIFE FUNCTION IMMEDIATELY AFFECTED**
Prey intake
-Increased DPERs
-Lost feeding opportunities

3

**VITAL RATES**

4

**POPULATION EFFECT**


Lusseau *et al.* (2009), Noren *et al.* (2009), Williams *et al.* (2009)

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**(Presence & Noise)**

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**Change in metabolic rate**

**LIFE FUNCTION IMMEDIATELY AFFECTED**
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-Increased DPERs


Noren *et al.* (2009), Williams *et al.* (2009)

# Energetic Cost of Surface Active Behaviors

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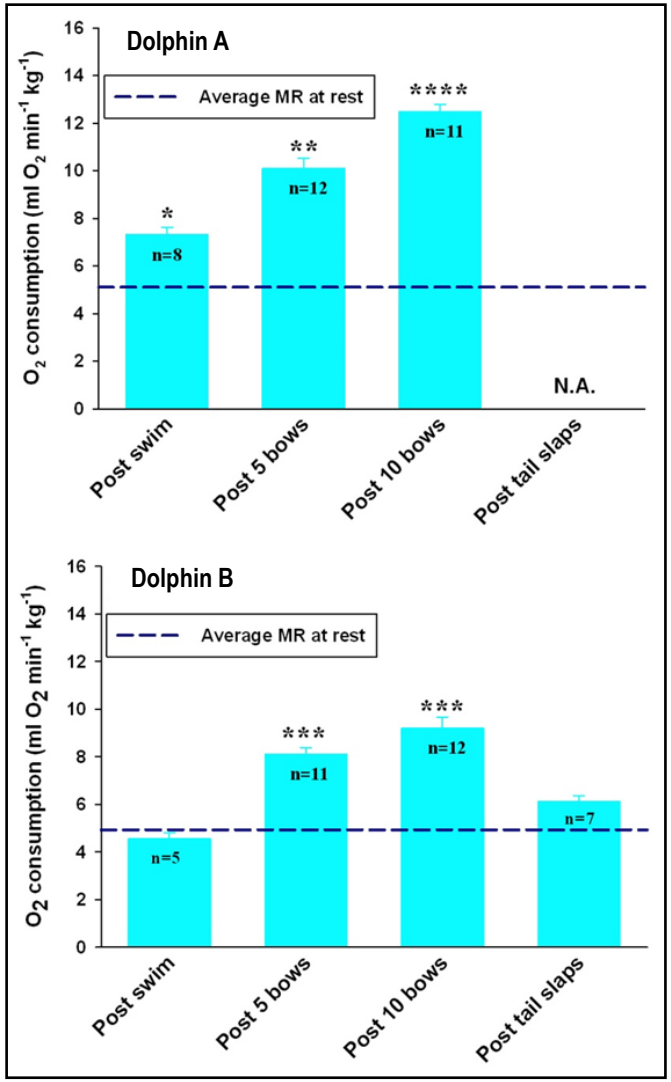
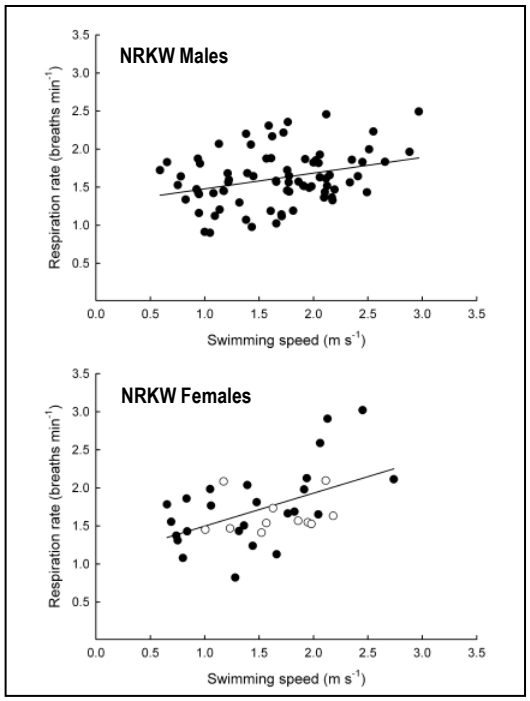
SABs can increase energy expenditure

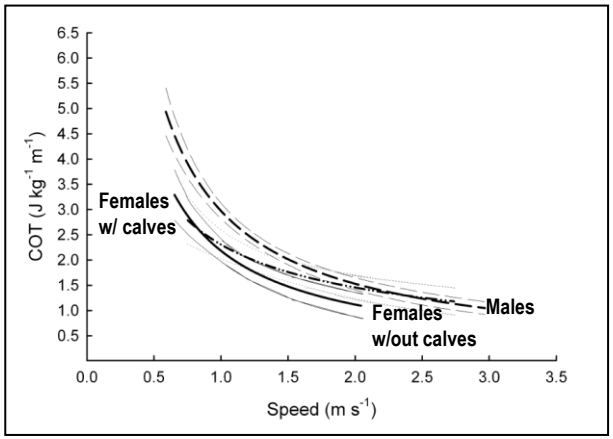
- Breaches are energetically costly
- Tail slaps are less costly




Noren, Dunkin, Williams (unpublished data)

# Energetic Cost of Increasing Swim Speed




Williams and Noren (2009)

| | FMR at SRKW forage speed (1.1 ms$^{-1}$*) | FMR at SRKW travel speed (2.2 ms$^{-1}$*) |
|---|---|---|
| **Adult Males (4434 kg*)** | 1153.7 MJ day$^{-1}$ (7.25 X Kleiber BMR) | 1186.1 MJ day$^{-1}$ (7.45 X Kleiber BMR) |
| **Adult Females (without calves, 3338 kg*)** | 636.6 MJ day$^{-1}$ (4.95X Kleiber BMR) | 649.7 MJ day$^{-1}$ (5.05X Kleiber BMR) |

* From Noren (2011)

# Do Behavioral Responses Significantly Increase Daily Prey Energy Requirements (DPERs)?


=

+


+ Vocal Modifications =?

# Conclusions

- Research has directly influenced management actions
  - Vessel regulations (2011)
- Current work assesses energetic impacts of vessel presence
  - Are SRKW DPERs (Noren 2011) significantly greater in the presence of vessels?
- Future work could assess the efficacy of vessel regulations in reducing SRKW behavioral responses
  - Too costly to repeat behavioral studies, given budget restrictions
  - Data collected during DTAG studies might provide insight into changes in activity states, but sample size may be limited

# Relevant Peer-Reviewed Publications Funded by NOAA NWFSC

**Southern Resident Killer Whale Behavioral Responses to Vessels**


*Lusseau D., Bain D.E., Williams R., Smith J.C. (2009) Vessel traffic disrupts the foraging behavior of southern resident killer whales *Orcinus orca*. Endangered Species Research 6:211–221.

*Noren D.P., Johnson A.H., Rehder D., Larson A. (2009) Close approaches by vessels elicit surface active behaviors by Southern Resident killer whales. Endangered Species Research 8:179-192.

*Williams R., Bain D.E., Smith J.C., Lusseau D. (2009) Effects of vessels on behaviour patterns of individual southern resident killer whales *Orcinus orca*. Endangered Species Research 6:199-209.


**Southern Resident Killer Whale Summer Critical Habitat Use and Potential Marine Protected Areas**


Ashe E., Noren D.P., Williams R. (2010) Animal behaviour and marine protected areas: Incorporating behavioural data into the selection of marine protected areas for an endangered killer whale population. Animal Conservation 13:196-203.

Noren D.P. and Hauser D.D.W. (in review) Surface-based observations can assess activity budgets and fine-scale habitat use by an endangered killer whale population.


**Northern Resident Killer Whale Behavioral Responses to Vessels**


Williams R. and Ashe E. (2007) Killer whale evasive tactics vary with boat number. Journal of Zoology 272:390-397.


**Resident Killer Whale Energetics**


Noren D.P. (2011) Estimated field metabolic rates and prey requirements of resident killer whales. Marine Mammal Science 27:60–77.

Williams R. and Noren D.P. (2009) Swimming speed, respiration rate and estimated cost of transport in adult killer \whales. Marine Mammal Science 25: 327–350.


*Denotes open access